Energy management for embedded systems

ECTS
3 credits

Component
INSTITUT NATIONAL DES SCIENCES APPLIQUEES TOULOUSE

Number of hours
40h

Presentation

Description

Ragone chart, power and energy density of various sources (primary and secondary batteries, fuel cells...)

Photovoltaic panels, thermogenerators, piezoelectric generators...

MPPT, multi-sources, auto-powering circuits ...

Composition of a DC machine with brushes; relations between external voltage and speed, between the electromagnetic torque and the current, torque to speed characteristic; electrical and mechanical equations for transient behavior; machine block diagram. Single-phase transformer; equations and electrical models; equivalent diagrams. Single and three phase diode rectifiers, instantaneous rectified voltage and average voltage; period and ripple rate; diodes sizing, power factor. Choppers, buck, boost, half and full bridge; continuous and discontinuous conduction mode; control strategies, power components for hard switching modes.

Organisation:

- The principles and theoretical basis are presented in lectures using Power Point slides whose copies are provided to students.

- In the tutorials case studies are presented for the design of certain specific elements such as machine parameters, transformer models, rectifier and converter. A handout of the tutorials is provided to students.

- The labworks deal with generation of PWM control signals for a chopper and the waveforms of current and voltage resulting in an inductive load. The H bridge is also controlled as a multilevel DC-AC inverter and an audio amplification application (class D) is implemented. Another part is devoted to the control via a microcontroller to a synchronous motor (brushless DC), this part has equal modeling with Matlab and Spice

Objectives

- At the end of this module, the student will have understood and be able to explain (main concepts):

- The performances of energy sources likely to be used in embedded systems,

- The methods of energy capture (harvesting / scavenging)

- circuit topologies for embedded energy management,

- The operation mode of a classical DC motor (actuator) as well as its electrical and mechanical characteristics.

- The operation mode of a AC transformer and its associated electrical models.

- The main structures and electrical characteristics of single and three phase rectifiers.

- The main structures of choppers, their properties, their reversibility and control strategies.

- The principle of torque and/or speed control of a DC machine using a chopper

The student will be able to:

- Analyze the energy requirements of an embedded system and to devise a solution,

- Analyze a mechanical system and identify its needs for motorizing, the type of converter that should be associated with the actuator.

- Dimension the elements of the electrical energy conversion chain which will drive the actuator.

- Choose the control strategy for the electronic switches of the converter in order to ensure its reliability.

Pre-requisites

General knowledge of electricity, alternating current, electrical circuits, analog and digital electronics as well as mathematical tools (Fourier and Laplace transforms) and the basics of automatic control (transfer functions and block diagrams).

Useful info

Place

› Toulouse